

Diabetes and climate change

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ABSTRACT

Background: Diabetes mellitus, a looming crisis, is approaching worldwide epidemic proportions. In 2018, 34.2 million Americans, or 10.5% of the population had diabetes. Climate change, and in particular rising global temperatures, may exacerbate various health issues, including diabetes and ultimately lead to increased mortality.

Objectives: To identify the impact of climate change on diabetes.

Methods: A systematic literature review of Pubmed (MEDLINE database of references and abstracts on life sciences and biomedical topics from the USA National Library of Medicine at the National Institutes of Health) and Scopus (Elsevier's abstract and citation database) with the following terms: 'diabetes' [AND] 'climate change'.

Results: The following risk factors for diabetes due to climate change were identified and discussed: extreme temperatures (heat), the risk of hospitalization, shortage of medical and food supplies and urbanization.

Conclusions: Diabetes and climate change are interconnected. Extreme weather events and rising temperatures may increase morbidity and mortality in patients living with diabetes, especially in those with cardiovascular complications. Failure to mitigate climate change and the diabetes epidemic threatens the lives of many people in the U.S. and beyond.

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1. Introduction

Diabetes mellitus, a looming crisis, is approaching worldwide epidemic proportions. In 2018, 34.2 million Americans, or 10.5% of the population had diabetes, while 7.3 million (21.4%) are estimated to be undiagnosed [1]. More than 1.5 million Americans are diagnosed with diabetes every year and diabetes remained the 7th leading cause of death in the USA in 2017 [1]. Diabetes is the most expensive disease in the U.S. Total annual costs of diagnosed diabetes have risen to 327 USD billion in 2018 with every 7th healthcare dollar being spent on diabetes [2]. There are less than five thousand endocrinologists who treat diabetes in the U.S, and the average wait time to see a specialist is 3 to 4 months.

In parallel, climate change is another looming (often ignored) crisis. The effect of industrialization, causing a constant increase in the release of greenhouse gases into the atmosphere may have contributed to raising Earth's temperature [3,4]. Climate change may have a significant implication on humans, animals and our society in general [5]. For example, an extreme event or climate disaster may destroy crops and create food insecurity. In 2017 Hurricane Harvey caused catastrophic rainfall-triggered flooding in Southeast Texas and the

Houston metropolitan area. This included severe flooding of the East Houston Regional Medical Center, a campus of the Bayshore Medical Center, forcing evacuations of patients and medical staff. Some U.S. hospitals are still struggling with shortages of drug supplies produced in Puerto Rico after Hurricane Maria disrupted production [6] at the Baxter pharmaceutical factory.

Could there be a connection between these two global disasters? The International Diabetes Federation published a report linking these two global crises [7]. These phenomena may be interconnected and may also have similar solutions.

2. Materials and methods

A systematic literature review of Pubmed (MEDLINE database of references and abstracts on life sciences and biomedical topics from the USA National Library of Medicine at the National Institutes of Health) and Scopus (Elsevier's abstract and citation database) with the following terms: 'diabetes' [AND] 'climate change'. Articles published in the past 10 years were selected and summarized below. Additional landmark studies were identified from Google Scholar by using the same search terms.

3. Results

3.1. The impact of climate change on diabetes

3.1.1. Heat

Climate change and diabetes could be interconnected both directly and indirectly. It is known that people living with diabetes are more prone to dehydration and cardiovascular events during extreme heat [8,9]. Higher frequency and duration of extreme heat episodes trigger other public health issues, with a potential impact on heat-related morbidity and mortality [9]. Mendez-Lazaro and colleagues modelled the impact of elevated air surface temperatures on cause-specific mortality. They found a statistically significant increase in mortality caused by stroke and cardiovascular disease during the summers of 2012 and 2013 in Puerto Rico; periods which experienced unusually high air surface temperatures [9]. Other researchers found that heat stress may exacerbate various health issues, including diabetes and ultimately lead to increased mortality [10,11]. Heat-related illness may depend on a number of different factors, such as physiologic adaptation to the local environment and socioeconomic status [12]. Age, heart disease and diabetes may exacerbate heat-related problems [4]. The US population is aging, which is expected to increase from 12.4% in 2000 to 20% in 2060 [13]. The elderly are more prone to heat stress.

Schwartz analyzed 160,062 deaths in Wayne County, Michigan, among persons who were 65 years of age or older and found that patients with diabetes had a higher risk of dying on hot days than people of other age groups (odds ratio = 1.17; 95% confidence interval = 1.04–1.32) [14]. Another observed association has been reported, between daily maximum temperature and Emergency Department visits in Atlanta, Georgia for all internal causes, including diabetes [15]. Scientists recently studied 4,474,943 general practitioner consultations in Great Britain during 2012–2014 and found increased odds of seeking medical consultation associated with high temperature (OR = 1.097 (95% confidence interval = 1.041, 1.156) per one degree Celsius above 22 degrees Celsius. Importantly, they found that these consultations were particularly high among patients with diabetes and cardiovascular disease [16].

The African continent is even more at risk for rising temperatures. Kapwata *et al* found that the African region will be subjected to more intense heat extremes over a shorter time period, with projections of increases of 4–6 degrees Celsius for the period 2071–2100 [17]. These rising temperatures may make young children and the elderly more vulnerable to heat-related illnesses.

3.1.2. Risk of hospitalization

Heart attack (acute myocardial infarction) is the leading cause of death among patients with diabetes and was found to occur more frequently during times of extreme temperature. In a large study of 53,769 myocardial infarction admissions to public hospitals in Hong Kong from 2002 to 2011, scientists found an increased risk for admission during periods of both high and low temperatures [18]. Hospitalized patients with diabetes may require more hospitalizations per year and may have a longer length of stay [19].

3.1.3. Shortage of medical supplies

The examples of recent climate disasters include Hurricane Katrina in 2005, Hurricane Harvey in 2017, during which people were left without life-saving medications, such as insulin. Small islands and underdeveloped countries are at particular risk for lack of medical supplies [9].

3.1.4. Shortage of food supply

Other risks may be associated with a shortage of food supply due to disruptions to agricultural production during extreme weather events. Often, when the food supply is limited, patients living with diabetes must rely on unhealthy processed food, which could worsen Type 2 diabetes and obesity. Rising obesity rates may force more food production of ‘cheap calories’ and car use, which in turn increases the demand for resources, thus ‘fueling climate change’ [3].

3.2. Urbanization, consumption and lifestyle

Sedentary lifestyle along with increased food consumption and urbanization may be a shared global vector of type 2 diabetes, obesity and climate change [3]. According to a 2018 report by the United Nations, 68% of the world’s population projected to live in urban areas by 2050 [20]. The combination of physical inactivity, unhealthy food and increased greenhouse emissions are all characteristics of the modern urbanized world. The same factors are increasing the risk of type 2 diabetes. Higher demand for cheaper processed foods and increased consumption of animal products have overtaken the traditional ‘healthy’ diets of staple grains and fresh produce [3]. If current U.S. obesity trends continue, more than 57% of today’s American youth will be obese by age 35 [21]. This would make obesity, the major risk for type 2 diabetes, a continuing major health problem in the USA.

3.3. Pharmaceutical industry and climate change

When the risk of disease rises, there may be more opportunities for pharmaceutical industry to grow. There will be a need for more prescription drugs and vaccines. Will the industry have the moral fortitude to make life-saving medications (e.g. insulin) available at a lower cost, especially in developing countries? The 2019 CDP Climate Change report identified 'risk and opportunities' for the biopharma industry [22]. Morgan Stanley recently identified a number of pharmaceutical companies (Moderna, Takeda Pharmaceuticals, Merck, Janssen Pharmaceuticals and Pfizer) which would become the main profiteers from climate change [23]. As the pharmaceutical industry is set to gain a new, prosperous venture from the selling of more medication, it is not clear which position would governmental policymakers take.

4. Discussion and possible solutions

4.1. Gap-analysis, urban planning and food policies

Acknowledging the crisis is the first step to address the problem and mitigate the risk. Like climate change, the diabetes epidemic will require a mitigation plan and careful, meticulous execution of the plan. Country leaders should collaborate and organize themselves around the issues and jointly tackle the challenges. Urban planning to implement 'active travel', such as safe cycling and walking should be encouraged. Food policies that support fresh produce and healthy diets should target low-income populations who are unable to afford high-quality produce. Finally, localized and sustainable agriculture, supporting small farmers should be encouraged and supported.

4.2. Preparedness plan

Appropriate preparedness plans could help mitigate the most adverse effects of extreme climate events. The Juvenile Diabetes Research Foundation joined forces with the Diabetes Disaster Response Coalition to ensure that 'people with diabetes have the support, insulin and supplies they need in advance of a major storm' [24]. These organizations created a 'patients with diabetes preparedness plan' [24].

Insulin For Life USA, Inc. provides insulin and disease management supplies cost free to those with diabetes in underdeveloped countries and disaster-affected areas [25]. This organization accepts donations of insulin, test strips and glucometers, which they distribute to those in need.

4.3. Identification of high-risk patients

Heat-protection advice to avoid exposure to both high and low temperatures should be provided to patients with diabetes by primary care physicians and endocrinologists

[18]. Patients with cardiovascular complications and diabetes should be considered high-risk and may require an individualized treatment management plan.

4.4. Unanswered questions

Why does the U.S. healthcare community ignore the harsh realities of the diabetes crisis? What would be the result of ineffective response planning by the healthcare community? What would be the cost of a delayed intervention?

5. Conclusions

Diabetes and climate change are interconnected. Extreme weather events and rising temperatures may increase morbidity and mortality in patients living with diabetes, especially those with cardiovascular complications. The disruption in the supply of life-saving medications (e.g. insulin) due to extreme weather may be a threat to people living with diabetes. Governments should implement urban planning and food policies to encourage 'healthy living'. Medical providers and healthcare organizations should identify high-risk patients with diabetes and assist in developing individualized preparedness plans. Failure to consider or anticipate the deleterious effects of climate change and their exacerbating effects on a diabetes epidemic may damage the lives of many people in the U.S. and beyond.

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